FISHERY RESEARCH

KOOTENAI RIVER FISHERIES INVESTIGATIONS: SALMONID STUDIES

RAINBOW TROUT TELEMETRY STUDIES SUMMARY REPORT

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ABSTRACT

Rainbow trout *Oncorhynchus mykiss* are native to the Kootenai River, Idaho, Montana, and British Columbia (BC), but little is known of their life history in the system downstream of Kootenai Falls, Montana. One goal of the Kootenai River Fisheries Recovery Investigations is to improve the rainbow trout fishing and the objective to have improved recruitment. In order to better manage the population, more information was needed, including identification of spawning areas and determining whether populations of rainbow trout range across state and international boundaries. Radio and ultrasonic telemetry were used to address the following tasks: 1) determine if the rainbow trout spawning population in the Deep Creek drainage, Idaho, is an adfluvial stock from Kootenay Lake, BC; 2) identify which tributaries to the Kootenai River, Idaho and Montana are used for rainbow trout spawning; and 3) determine if adfluvial rainbow trout spawn in Idaho or Montana tributaries. Of 15 radio-tagged rainbow trout tagged in the Deep Creek drainage, seven out-migrated and were located in Kootenay Lake, BC; an eighth radio tag was found on the shore of Kootenay Lake, indicating that a majority of the spawning population in the Deep Creek drainage is adfluvial. Rainbow trout tagged upstream of Deep Creek in the Kootenai River were later found in Boulder Creek, Idaho during the spawning season. Rainbow trout were also located in Caboose and Debt creeks and the Moyie River in Idaho, and Callahan, Lake, and Star creeks in Montana during the spawning season. One rainbow trout that spawned in Boulder Creek was later relocated in Kootenay Lake, indicating that adfluvial rainbow trout also spawn in Boulder Creek. A one-way migration distance of up to 198 km was observed for an adfluvial rainbow trout. Radio telemetry of adfluvial rainbow trout in this study were the longest in travel distance to be documented in the literature. The fact that rainbow trout range across state and international boundaries in the Kootenai River drainage calls for a multiagency dialogue regarding management.

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INTRODUCTION

One goal of the Kootenai River Fisheries Recovery Investigations is to improve the rainbow trout fishing with an objective to have improved recruitment. An understanding of the life history of rainbow trout *Oncorhynchus mykiss* in the Kootenai River is needed to make informed management decisions. Rainbow trout exhibit a variety of life history patterns including anadromous (steelhead), fluvial, adfluvial, and resident forms (Van Velson 1974; Behnke 1992; Meka et al. 2003). Even within these general life history patterns, variations can exist among populations (Carl et al. 1959; Hartman et al. 1962; Scott and Crossman 1973). Also, some river systems contain rainbow trout with more than one life history pattern (Scott and Crossman 1973; Meka et al. 2003), making generalized management decisions difficult.

Rainbow trout are native to the Kootenai River drainage of Idaho, Montana (MT), USA and British Columbia (BC), Canada where they are also found in Kootenay Lake, BC (Simpson and Wallace 1982). They have been separated in this system from anadromous influence by a barrier falls located on the Kootenay River downstream of the West Arm of Kootenay Lake (Behnke 1992). Rainbow trout can potentially range upstream in the Kootenai River to Kootenai Falls, MT, about 190 river kilometers (rkm) upstream from Kootenay Lake (Chapman and May 1986). Each state and province has their own regulations for managing rainbow trout in this system; the effects of these regulations are difficult to assess without an understanding of life history traits and the potential for transboundary movements.

Rainbow trout in the Kootenai River of Idaho and MT are thought to have at least two life history patterns. A fluvial fish in the mainstem Kootenai River, likely spawning in tributaries in Idaho and MT, and an adfluvial rainbow trout from Kootenay Lake, BC, that are believed to spawn in Kootenai River tributaries in Idaho and MT.

Because the rainbow trout population in the Idaho section of the Kootenai River is thought to be recruitment limited, resulting in low adult densities, identifying and protecting spawning tributaries and enhancing spawning and rearing habitat could help increase recruitment (Walters et al. 2005). To improve management effectiveness for rainbow trout conservation and sport fisheries, more life history information is needed, including identification of spawning areas and whether separate spawning patterns exist.

To better define spawning locations and movement of rainbow trout this study had three tasks: 1) determine if the rainbow trout spawning in the Deep Creek drainage was from an adfluvial stock from Kootenay Lake, BC; 2) identify which tributaries fluvial rainbow trout residing in the Kootenai River, Idaho and MT spawn in; and 3) determine if adfluvial rainbow trout spawn in other Idaho and MT tributaries besides the Deep Creek drainage.

STUDY AREA

The Kootenai River originates in Kootenay National Park, BC, Canada, draining an area of 49,987 km^2 (Bonde and Bush 1975). The river flows south into MT and turns northwest at Jennings, near the site of Libby Dam, at river kilometer (rkm) 352.4 (Figure 1). Until recently, Kootenai Falls, 42 rkm downstream of Libby Dam at rkm 310, was presumed to be a migration barrier to upstream fish movement (Chapman and May 1986), though a bull trout *Salvelinus confluentus* was lately documented to have passed upstream through the falls reach (M. Hensler, Montana Fish, Wildlife and Parks, personal communication). From MT, the Kootenai River passes into Idaho at rkm 275.7. In Idaho, the river has the following three reaches (Barton

2004): 1) the canyon reach (22 km) from the MT border to the Moyie River, 2) the braided reach (10 km) from the Moyie River to Bonners Ferry, and 3) the meandering Reach (73 km) from Bonners Ferry to the Canadian border. Upstream from Bonners Ferry, the channel has an average gradient of 0.6 m/km, and the velocities are often higher than 0.8 m/s. Downstream from Bonners Ferry, Idaho, the river slows to velocities typically less than 0.4 m/s, the average gradient is 0.02 m/km, and the channel deepens as the river meanders north through the Kootenai River Valley. The river returns to BC at rkm 170 and enters the South Arm of Kootenay Lake at rkm 121. The river leaves the lake through the West Arm of Kootenay Lake and flows to its confluence with the Columbia River at Castlegar, BC. Lower Bonnington Falls (now a series of four dams), 16 km downstream from Nelson, BC, formed a natural barrier to upstream movement of fish from the lower Kootenay River (Northcote 1973).

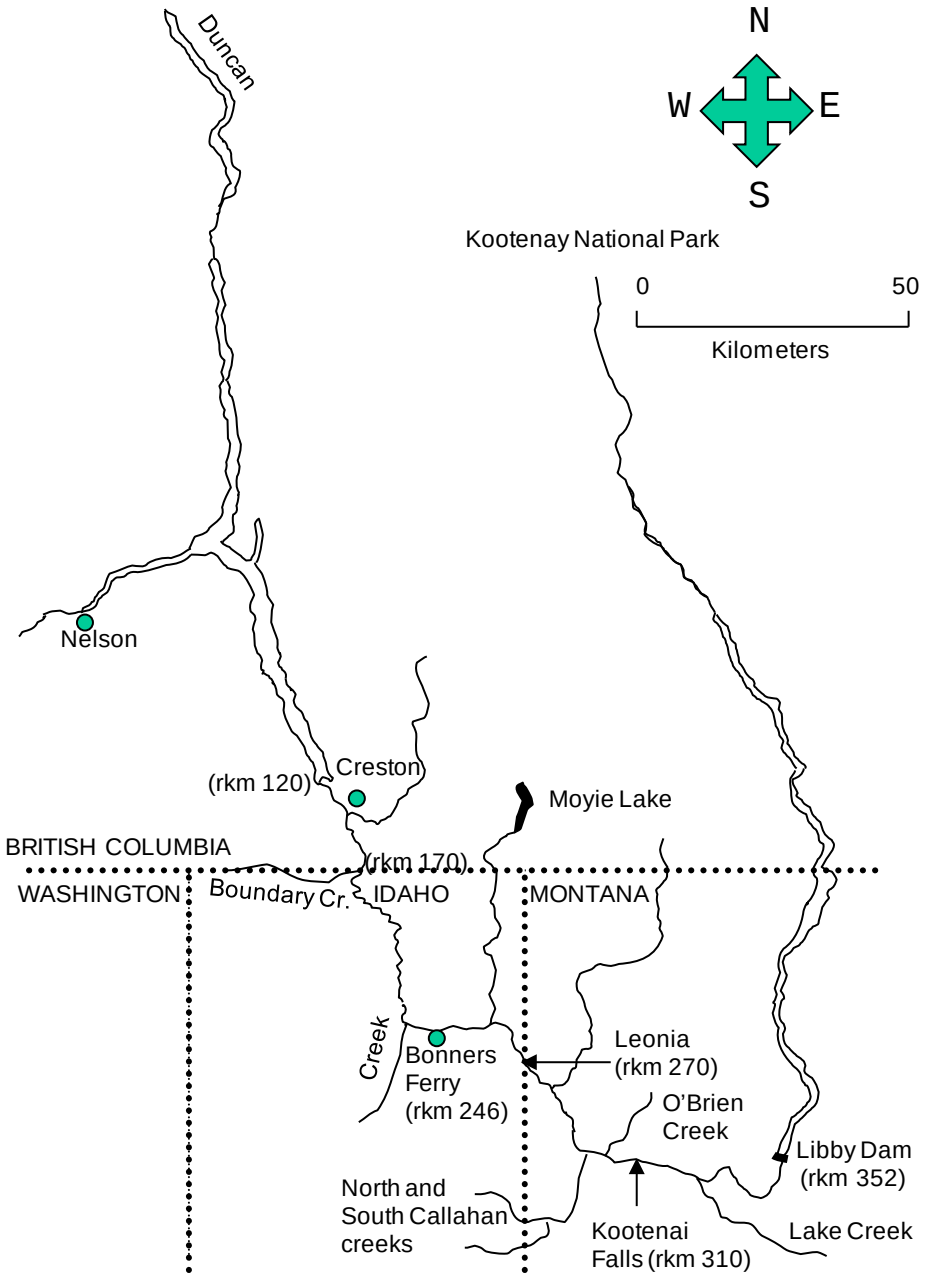

Figure 1. The Kootenai (Kootenay) River drainage showing some major tributaries and landmarks.

METHODS

Radio and ultrasonic telemetry were used to monitor rainbow trout. In the Deep Creek drainage, fish were captured by hook-and-line, trapping, and backpack electrofishing. Most fish were captured at the mouths of Deep Creek tributaries prior to spawning (Appendix 1). In the Kootenai River, 59 rainbow trout were radio-tagged from 1998 through 2005 (Appendix 2). Most trout were collected using boat electrofishing from rkm 244.5 to 275.5 during the spring and fall. However, one rainbow trout (Fish ID 73, Appendix 2) was collected from a weir trap on Caboose Creek. Spring electrofishing was conducted in the Kootenai River, Idaho to increase the chance of collecting adfluvial rainbow trout from Kootenay Lake along with fluvial fish from the river. Fall electrofishing targeted the fluvial fish as adfluvial rainbow trout would likely have returned to Kootenay Lake by the fall. A total of 33 rainbow trout were radio-tagged in the spring, while 26 rainbow trout were tagged in the fall.

Following the recommendation of Winter (1996), transmitters weighed no more than 2% of the fishes weight. We used the estimated post-spawn weight of females to determine their suitability for tagging. Estimated post-spawn weight was derived by subtracting the maximum percent body weight of developed ovaries for rainbow trout (8%) (Kaya 1977) from the total weight of the fish at time of capture.

Before radio-tagging, captured fish were anesthetized, weighed (g), measured for total length (TL) in mm, and their gender determined if possible. Gender was determined if gametes could be expressed with moderate pressure to the ventral region or if a kype (male) was obvious. The fish were then placed ventral side up in a wooden surgery cradle. The cradle was lined with 6 mm hardware cloth to minimize damage/removal of the fish's protective mucus layer. The cradle was placed in a plastic container holding an anesthetic bath. The cradle was angled downward, partially submerging the gills, while the abdomen (surgical area) remained above the water line. During surgery, an assistant bathed the gills with anesthetic or fresh water as needed.

Surgical instruments were sterilized by soaking in alcohol prior to surgery. An incision into the abdominal cavity was made slightly to either side of the midventral line about halfway between the pectoral and pelvic fins. The body wall was then pierced with a catheter needle just anterior to the pelvic girdle and about 1/3 the distance from the ventral surface to the lateral line, to serve as an exit hole for the antenna. We used a slightly modified shielded needle technique (Ross and Kleiner 1982). To prevent internal damage from the catheter, we inserted a small spoon through the abdominal incision to shield the internal organs while piercing the body wall. The transmitter was then placed into the abdominal cavity with the catheter needle still inserted through the body wall. The antenna was then threaded into the catheter needle and the needle extracted, in turn leaving the antenna exiting the hole through the body wall. The abdominal incisions were then closed with 3/0 polypropylene sutures using a cutting NCP-2 needle. To expedite recovery, an assistant began bathing the gills with fresh water at initiation of wound closure. Trout were typically held in cages placed in the river until each fully recovered (typically 20 min) and then released at the capture site, though some fish were released the following morning.

Low frequency (30–31 Mhtz.) radio tags (Advanced Telemetry Systems [Isanti, Minnesota]) were used to maximize signal transmission in the deep, oligotrophic waters of the Kootenay River (Winter 1996). Five different transmitters were used with life expectancies of 360, 730, and 912 d; models 6, F1840, F1850, 5955, and 10-35. Most radio transmitters were active for 8 h and off for 16 h each d in order to increase the lifespan of the tag. Radio signals

were at the rate of 40 or 50 pulses per minute (ppm). In 2005 Vemco V13-1L-R04K coded acoustic transmitters were also surgically implanted in several rainbow trout to incorporate the use of stationary sonic receivers already in place (Neufeld and Rust 2009). Each sonic transmitter was 13 mm in diameter and 36 mm long, had an approximate battery life of three years, and weighed 6 grams in water. An array of passive Vemco VR2 sonic single channel fixed telemetry receivers were previously deployed from Kootenay Lake, BC upstream into Idaho near the Montana border (Rust and Wakkinen 2007; Neufeld and Rust 2009).

For rainbow trout tagged in the Deep Creek drainage, radio telemetry surveys were typically conducted every 1-2 d by vehicle during April–June while fish remained in the spawning tributaries. Telemetry was also conducted from fixed-wing aircraft weekly during May and June to track the fish as they out-migrated from the Deep Creek drainage. Aerial flights occurred along the Kootenai River from approximately rkm 240.6 downstream to and including Kootenay Lake. Three fixed location receiver stations at rkm 133, 237.5, and 245.3 along the Kootenai River helped direct the radio aerial searches and provide last known locations in the event fish were lost.

Locations of rainbow trout were determined during the spawning migration periods for all fish at least once a month, and sometimes once a week (Figure 1). These fish were searched for by fixed-wing aircraft or by boat. The search areas included the South and West Arms of Kootenay Lake, BC upstream to Kootenai Falls, MT, including Idaho and MT tributaries up to the first migration barrier (Figure 1). Radio signals from the same location in spawning tributaries lasting beyond the spawning season were assumed to represent mortalities or shed tags. Fish with ultrasonic transmitters were passively monitored via the stationary sonic receivers deployed at 53 locations, beginning in the North and South Arms of Kootenay Lake, BC, and continuing upstream in the Kootenai River to the Idaho-MT border (Neufeld and Rust 2009).

The spawning migration period was defined as the time rainbow trout began upstream movements towards spawning tributaries until the time they returned to a post-spawn home range location (an area where movement was typically <0.5 km between telemetry locations). The resultant rainbow trout spawning migration period was March 1—June 20. Movements of rainbow trout during this period included upstream movement of ≥0.5 km for rainbow trout relative to the home range occupied outside of the spawning migration period, and when relevant, included movement into a tributary, typically followed by movement back downstream. The spawning season was defined as the time rainbow trout were in tributaries to build redds and spawn, based on water temperatures and observations of fish (Holecek and Walters 2007). The rainbow trout spawning season was defined as April 1—June 20; we expected some fish would move to spawning tributaries later than others.

RESULTS

Deep Creek Drainage

A total of 22 rainbow trout were radio-tagged in the Deep Creek drainage from April 8—May 14, 1998 (Appendix 1). Fifteen of these fish out-migrated to the Kootenai River after spawning. Seven of the 15 out-migrants were eventually located in Kootenay Lake, while the radio tag from an eighth fish (fish 108) was found on the shore of the West Arm of Kootenay Lake by a citizen on July 1, 1998. One rainbow trout was last located at rkm 122.5, 1.5 km upstream of the lake; three fish were last located by the fixed station receiver at rkm 133, 13

river kilometers upstream of Kootenay Lake (Appendix 3); and one was last located at rkm 137.5. One of the two remaining Deep Creek out-migrants (fish 106) was located several times in June and July near the Idaho-BC border (rkm 170), while the last fish (fish 114) was last located at rkm 164.9 on May 7, 1998. Seven tagged fish were not located in the creek, did not out-migrate from the Deep Creek drainage, and were considered to be mortalities or their tags had failed.

The one-way migration distance between Kootenay Lake and the spawning tributaries of the Deep Creek drainage was approximately 135 river kilometers (rkms). Several fish moved as far as 180 rkms one way from the tagging site in Deep Creek to locations in the West Arm of Kootenay Lake. Post-spawn rainbow trout traveled approximately 124 rkms between the spawning tributaries and the fixed location receiving station near the delta of Kootenay Lake in as little as five days.

Kootenai River

Of the 59 rainbow trout tagged (three were also tagged with ultrasonic transmitters) in the Kootenai River, 48 were monitored during the spawning season, while the remaining 11 were never located (Appendix 2). Eighteen rainbow trout were located in seven Idaho and MT tributaries during the spawning season (Table 1). In Idaho, Boulder Creek received the most use during the spawning season with 10 fish migrating into it. In MT, two fish each were located in Callahan and Lake creeks.

Eleven of the 48 rainbow trout monitored during the spawning season moved upstream during the spawning period but were not located in tributaries and likely did not spawn. Seven of these fish were found in the Kootenai River in MT, including rainbow trout 35 and 47 located at rkm 309 and 310, respectively, at Kootenai Falls, and one fish each; Star Creek (fish 69) and the Yaak River (fish 30) were located at their confluence with the Kootenai River.

A total of 12 of 30 (40%) rainbow trout tagged in the Kootenai River in Idaho moved upstream into Montana during the spawning migration. Six of these fish were tagged in the fall, while six others were tagged in the spring. Two additional rainbow trout (fish 40 and 79) were initially located in MT but subsequently moved downstream into Boulder Creek during the spawning period.

Four of the 30 rainbow trout tagged in Idaho (this figure included located fish that were not subsequently found) moved upstream during the spawning migration period but remained in Idaho. Two of these fish were found near the mouths of tributaries, including Boulder Creek (fish 66) and Sand Creek (fish 74) while the other two remained in the Kootenai River. Rainbow trout 31, dual tagged on April 28, 2005, was located in Boulder Creek during the 2005 spawning season via radio-telemetry and later detected in Kootenay Lake on June 8, 2005 at rkm 113 by an ultrasonic receiver. This fish was detected at rkm 81.5 in Kootenay Lake on June 13, 2005, 194 rkms downstream from Boulder Creek. In 2006, rainbow trout 31 was first detected on April 9 at rkm 81, and then detected by several ultrasonic receiver sites in the Kootenai River as far upstream as rkm 256 on June 10, 2006, an upstream movement of 175 rkms. It could not be determined if rainbow trout 31 entered a tributary in 2006 because its radio battery had expired. Rainbow trout 81, tagged in the Kootenai River on April 8, 2002, was located at rkm 109 in Kootenay Lake on July 3, 2002, after a previous location at rkm 272.6 on May 23, 2002. It is unknown if this fish ever entered a tributary to spawn. On approximately August 15, 2002, an angler harvested rainbow trout 81 from Kootenay Lake, at rkm 75, 198 rkms downstream of its previous location.

Table 1. Maximum upstream river kilometer (rkm) for Kootenai River locations of radio-tagged rainbow trout that moved upstream during the spawning migration period (March 1—June 30), and dates and locations of those fish that were located in tributaries.

Fish ID	Year	First date located in tributary	Last date located in tributary	Name of tributary	Water temperature when first located in tributary (°C)	Minimum water temperature while in tributary (°C)	Maximum water temperature while in tributary (°C)	Date when first located back in Kootenai River	Maximum upstream location in Kootenai River (rkm)
30	2005								285.5
31	2005	5/18	5/27	Boulder Cr.				6/3/2005	275.3
31	2006								256
33	2001	5/23	5/30	Callahan Cr.					299.5
34	1999	5/11	5/11	Caboose Cr.				5/13/1999	271
35	1999								309
40	1999	4/22	5/6	Boulder Cr.				5/17/1999	280.9
41	1999								295
47	1999								310
49	2005								268.5
51	1999	5/6	6/21	Callahan Cr.				7/12/1999	299.5
52	1999	5/11	5/24	Boulder Cr.				5/27/1999	275.4
56	1999	5/6	5/27	Lake Cr.				6/1/1999	300.3
58	1999	5/17	6/7	Lake Cr.				6/14/1999	300.3
59	2000	5/16	5/23	Boulder Cr.				7/5/2000	275.4
62	2001	5/18	5/23	Debt Cr.				5/26/2001	271.5
63	2001	5/30	5/30	Star Cr.				6/11/2001	285.6
64	2001	4/18	4/18	Boulder Cr.				4/23/2001	275.3
66	2001								275.3
67	2001	4/22	4/22	Moyie R.				5/2/2001	260.4
69	2001								285.6
73	2002	5/13	6/3	Caboose Cr.	5.8	4.2	8.4	6/4/2002	270.7
74	2003								266.9
76	2005	4/27	5/4	Boulder Cr.				5/10/2005	275.3
79	2002	6/4	12/5	Boulder Cr.	5.9				299
80	2002								283.5
81	2002								272.6
82	2002								299.5
85	2002	6/4	6/6	Boulder Cr.	5.9	4.5	7.8	6/11/2002	275.6
86	2002	5/18	6/24	Boulder Cr.	4.2				275.5

DISCUSSION

Radio telemetry of rainbow trout tagged in the Deep Creek drainage showed that a majority of this spawning population is an adfluvial stock residing in Kootenay Lake. Eight of the 15 radio-tagged rainbow trout that out-migrated from the Deep Creek drainage were later located in Kootenay Lake. Three additional rainbow trout were last located by the fixed station receiver at rkm 133, only 13 rkms from Kootenay Lake, but they could not be located after that. None of the fish that were eventually located remained in the Deep Creek drainage. It is possible some fish with failed transmitters could have remained in the drainage but this seems unlikely given their large size and the unproductive nature of rainbow trout in the system.

Barriers to rainbow trout migration into some Deep Creek tributaries were noted in this telemetry study. It is not known if these barriers limit access to suitable spawning habitat or are inaccessible because some adult fish are too small to overcome them. Removal of barriers such as those in Twenty Mile and Browns creek may improve spawning habitat use and rainbow trout recruitment.

A second unknown concern may be winter operations of Libby Dam (power peaking) that may have an effect on rainbow trout movements as well as the effect of warmer water releases from the dam during the winter (Partridge 1983). Power peaking raises and lowers the river stage and river velocities thereby creating different habitat conditions.

Boulder Creek appears to be the most important rainbow trout spawning tributary in the Kootenai River, Idaho that is upstream of Deep Creek. Ten of 18 rainbow trout tagged in the canyon reach of Idaho and MT and subsequently located in Kootenai River tributaries were located in Boulder Creek during the spawning season. Walters et al. (2005) reported that Boulder Creek appeared to be the largest source of juvenile rainbow trout recruits to the Kootenai River in the canyon reach of Idaho based on both electrofishing and spring trapping of out migrating age 0 and 1 fish.

Although the majority of rainbow trout in our study of Kootenai River fish upstream of Deep Creek were fluvial, at least one adfluvial rainbow trout was indentified; it too spawned in Boulder Creek (fish 31). Rainbow trout 31 was located in Boulder Creek during the 2005 spawning season and later detected in Kootenay Lake. A second fish moved between the lake and river but it was never detected in a tributary during the spawning season. Anglers have reported catching large rainbow trout in other tributaries upstream of Deep Creek including the Moyie River and Callahan Creek that may have come from Kootenay Lake (senior author's communication with local anglers). However, because only one tagged fish showed this pattern, the number of adfluvial rainbow trout in the population above Bonners Ferry appears low.

We estimated that 20% of the fluvial rainbow trout residing in the Kootenai River, Idaho, is supported by recruitment from MT. Of the rainbow trout that were tagged in Idaho during the fall, six were found in MT during the spawning migration period. This observation is supported by evidence that rainbow trout home to their natal areas to spawn (Lindsey et al. 1959; Biette et al. 1981).

Migration distances observed for the adfluvial rainbow trout in this study are the longest we found in the literature. Rainbow trout tagged in the Kootenai River traveled up to 198 rkms downstream to Kootenay Lake, while some of those tagged in the Deep Creek drainage after spawning migrated downstream up to 180 rkms. Van Velson (1974) documented non-native adfluvial rainbow trout migrating as far as 145 km from McConaughy Reservoir, Nebraska, to

spawn in tributaries of the North Platte River. Hockersmith et al. (1995) documented spawning movements of up to 87 kms for rainbow trout in the upper Yakima River Basin, Washington. In an Alaska study, rainbow trout moved one way up to 102 km during spawning migrations (Meka et al. 2003). Assuming the fish we tagged in Deep Creek had begun migrating in Kootenai Lake, some fish in the stock could move an astounding 400 rkm in their spawning migration to spawning tributaries and then a return to Kootenay Lake.

Results from this study suggest that a multiagency dialogue regarding management of rainbow trout in the Kootenai River system may be warranted. Radio telemetry indicated that the movements of some rainbow trout are transboundary with adfluvial rainbow trout moving from Kootenay Lake, BC to Deep Creek and Kootenai Falls, MT, there are fluvial fish moving from Idaho to and from MT, and the fluvial rainbow trout population in Idaho (above Bonners Ferry) is partly dependent on recruitment from Montana. With the extent of transboundary movement an important measure may be to consider more uniform fishing regulations. Sport fishing regulations in the mainstem Kootenai River in Idaho are currently two fish over 406 mm and year round fishing, regulations designed to foster population increases (Walters 2005). However, regulations in the spawning tributaries in Idaho are currently a limit of six rainbow trout and a fishing closure from December 1 through the Friday before Memorial Day. Regulations for rainbow trout in Kootenay Lake, BC are currently one fish over 500 mm and an April 1 through March 31 closure, a November 1 through March 31 catch and release, while tributaries are two fish of any length. In Montana there is a four daily limit of rainbow trout in the Kootenai River with three under 330 mm and one over, year round fishing while the tributaries have a daily limit of five and one over 356 mm.

RECOMMENDATIONS

1. A spawning and rearing habitat inventory should take place in Idaho tributaries. If barrier removal and habitat work could improve spawning habitat for rainbow trout and improve recruitment.

2. A tagging program should be initiated to estimate exploitation rate and to determine if the harvest proportion of adfluvial rainbow trout residing in both Idaho and BC is impairing population numbers (recruitment limitation) in Idaho.

3. A multiagency group of biologists from British Columbia, Idaho, and Montana should discuss future direction for rainbow trout research and management in the Kootenai River.

ACKNOWLEDGEMENTS

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APPENDICES

Appendix 1. Tagging date, length, weight, tagging site, and telemetry disposition of rainbow trout implanted with radio tags in the Deep Creek drainage, 1998.

Fish ID	Tag date	Total length (mm)	Weight (g)	Tagging site	Water temperature (°C)	Capture method	Sex	Tag weight (g)	Last telemetry date	Last telemetry location (rkm)	Date first located in Kootenay Lake
100	04/11/98	418	624	Deep Cr. at mouth of Trail Cr.	6	Hook & Line	F	7.9	05/12/98	113.0	05/07/98
101	04/18/98	432	567	Deep Cr. at mouth of Trail Cr.	4.5	Hook & Line	F	7.9	06/16/98	Deep Cr.	
102	04/18/98	403	510	Deep Cr.	4.5	Hook & Line	F	7.9	06/08/98	Deep Cr.	
103	04/21/98	413	624	Deep Cr. at mouth of Fall Cr.	10	Hook & Line	F	7.9	05/26/98	114.0	05/26/98
104	04/22/98	425	553	Deep Cr. at mouth of Trail Cr.	7	Hook & Line	M	7.9	05/14/98	133.0	
105	04/18/98	423	709	Deep Cr. at mouth of Trail Cr.	4.5	Hook & Line	F	7.9	06/16/98	Deep Cr.	
106	04/21/98	411	539	Deep Cr. at mouth of Trail Cr.	10	Hook & Line	F	7.9	07/21/98	164.5	
107	04/12/98	392	510	Deep Cr. at mouth of Trail Cr.	6.5	Hook & Line	M	7.9	06/16/98	122.5	
108[a]	04/20/98	435	709	Deep Cr. at mouth of Trail Cr.	9	Hook & Line	F	10.7	05/19/98	133.0	07/01/98[a]
109	04/23/98	435	652	Deep Cr. at mouth of Trail Cr.	7	Hook & Line	M	10.7	06/16/98	137.5	
110	04/18/98	424	567	Deep Cr. at mouth of Trail Cr.	4.5	Hook & Line	F	10.7	05/17/98	133.0	
111	05/14/98	453	737	Trail Cr.	10	Hook & Line	M	10.7	07/21/98	77.0	07/21/98
112	04/18/98	420	624	Deep Cr.	4.5	Hook & Line	M	10.7	05/21/98	Deep Cr.	
113	04/18/98	444	737	Deep Cr.	4.5	Hook & Line	M	10.7	07/21/98	77.0	07/21/98
114	04/23/98	438	680	Deep Cr. at mouth of Trail Cr.	7	Hook & Line	F	10.7	05/07/98	164.9	
115	04/28/98	513	1106	Trail Cr.	6.5	E-fish	M	10.7	06/08/98	Deep Cr.	
116	04/28/98	487	992	Trail Cr.	6.5	E-fish	F	10.7	06/08/98	Deep Cr.	
117	05/11/98	455	808	Deep Cr.	10	Screw trap	F	10.7	05/19/98	118.5	05/19/98
118	04/23/98	445	737	Deep Cr. at mouth of Trail Cr.	7	Hook & Line	F	10.7	06/26/98	78.0	06/26/98
119	04/23/98	450	680	Deep Cr. at mouth of Trail Cr.	7	Hook & Line	F	10.7	06/26/98	77.0	06/26/98
120	04/08/98	360	482	Trail Cr.	5.5	E-fish	M	7.9	06/16/98	Deep Cr.	
121	04/12/98	410	624	Deep Cr. at mouth of Trail Cr.	6.5	Hook & Line	M	7.9	05/13/98	133.0	

[a] This fish was not located in Kootenay Lake but the radio tag was found on the beach in the West Arm of Kootenay Lake on 7/1/1998.

Appendix 2. Trout tagged with radio and ultrasonic tags in the Kootenai River drainage, 1998–2005, U = undetermined sex.

Fish ID	Radio frequency	Sonic tag number	Total length (mm)	Fork length (mm)	Weight (g)	Sex	Tag date	Tag location (rkm)	Last contact date	Monitored during spawning?	Expected tag expiration date	Harvest date
28	30.01		410			U	4/11/2000	263	4/11/2000	N	8/20/2000	
29	30.090		417		581	U	4/21/2000	270.6	1/4/2001	Y	12/31/2000	
30	30.090	4718F	464		884	F	5/5/2005	272.2	5/30/2005	Y	9/22/2005	5/30/2005
31	30.1	4723F	454		874	U	4/28/2005	275.5	6/26/2006	Y	9/15/2005	
32	30.120		419		539	U	9/17/1998	262.5	9/28/1999	Y	8/30/1999	
33	30.120		560		1463	M	4/12/2001	268.5	6/23/2003	Y	3/2/2003	
34	30.14		417		624	U	9/21/1998	270	9/28/1999	Y	9/4/1999	
35	30.180		383		539	U	10/1/1998	275.5	9/28/1999	Y	9/14/1999	
36	30.180		375		489	U	5/22/2000	270	10/26/2000	Y	10/1/2000	
37	30.211		402		620	U	5/22/2000	273	10/31/2000	Y	10/1/2000	
38	30.261		391		554	U	5/22/2000	274	6/6/2000	Y	10/1/2000	
39	30.312		465		822	F	3/30/1999	264	4/12/1999	N	3/9/2000	
40	30.503		439		666	F	3/30/1999	264	7/12/1999	Y	10/20/1999	
41	30.522		413		680	U	9/15/1998	262.5	9/28/1999	Y	8/28/1999	
42	30.541		389		482	U	9/21/1998	271.5	9/28/1999	Y	9/4/1999	
43	30.552		386		425	U	9/24/1998	254	11/16/1998	N	9/7/1999	
44	30.562		386		454	U	10/1/1998	272.5	4/8/1999	N	9/14/1999	
45	30.573		377		454	U	9/22/1998	263	9/28/1999	Y	4/11/1999	
46	30.583		407		624	U	9/22/1998	268	3/15/1999	N	4/11/1999	
47	30.592		403		454	U	3/10/1999	274.5	6/21/1999	Y	2/19/2000	
48	30.602		422		567	F	3/30/1999	264	4/5/1999	N	3/10/2000	
49	30.602	4719F	487		1085	M	4/19/2005	264.7	9/9/2005	Y	9/6/2005	
50	30.612		359		454	U	10/1/1998	272.5	9/28/1999	Y	9/14/1999	
51	30.633		402		539	U	9/22/1998	266	9/28/1999	Y	4/11/1999	
52	30.641		367		454	U	9/21/1998	270	7/12/1999	Y	9/4/1999	
53	30.682		409		680	U	9/15/1998	262.5	8/31/1999	N	8/28/1999	
54	30.701		391		539	U	10/1/1998	275.5	9/28/1999	Y	9/14/1999	
55	30.722		426		680	U	9/24/1998	257.5	9/28/1999	Y	9/7/1999	
56	30.742		409		652	U	9/21/1998	271.5	6/21/1999	Y	9/4/1999	
57	30.762		380		539	U	10/1/1998	272.5	9/28/1999	Y	9/14/1999	
58	30.772		421		652	U	9/22/1998	266	9/28/1999	Y	9/5/1999	
59	30.782		421			F	4/11/2000	263	1/4/2001	Y	4/11/2001	
60	30.792		381		454	U	9/21/1998	271.5	9/28/1999	Y	9/4/1999	
61	30.801		440		811	U	3/22/2000	266.5	3/22/2000	N	5/22/2001	

Appendix 2. Continued.

Fish ID	Radio frequency	Sonic tag number	Total length (mm)	Fork length (mm)	Weight (g)	Sex	Tag date	Tag location (rkm)	Last contact date	Monitored during spawning?	Expected tag expiration date	Harvest date
62	31.202		361		461	U	9/21/2000	270.5	8/22/2001	Y	8/28/2001	
63	31.212		387		598	U	9/28/2000	268.5	8/22/2001	Y	9/5/2001	
64	31.222		379		525	U	9/28/2000	268.5	11/5/2001	Y	9/5/2001	
65	31.232		424		700	U	10/10/2000	252.5	8/1/2001	Y	9/20/2001	
66	31.242		405		683	M	3/21/2001	265	6/11/2001	Y	3/1/2002	8/21/2001
67	31.253		421		736	F	3/21/2001	265	2/13/2002	Y	3/1/2002	
68	31.262		406		596	U	9/28/2000	268.5	4/25/2001	N	9/5/2001	
69	31.272		366		510	U	3/21/2001	265	3/13/2002	Y	3/1/2002	
70	31.282		448		759	U	10/10/2000	252.5	5/2/2001	N	9/20/2001	
71	31.293		384		517	U	9/28/2000	266.5	6/20/2001	Y	9/5/2001	6/20/2001
72	31.443		396		542	U	5/1/2001	272.2	9/8/2001	Y	4/11/2002	9/8/2001
73	31.462		471		947	M	5/13/2002	270.7	6/6/2002	Y	4/18/2003	
74	31.482		356		412	U	4/23/2002	262.4	6/30/2003	Y	3/29/2003	
75	31.502		349		451	U	5/1/2001	272.2	7/10/2002	Y	4/11/2002	
76	31.523		444		886	U	4/12/2005	264.7	3/1/2006	Y	3/18/2006	
77	31.543		436		750	U	4/12/2005	264.7	6/15/2005	Y	3/18/2006	
78	31.583		358		464	U	4/11/2002	268.6	12/5/2002	Y	3/17/2003	
79	31.602		331		430	U	4/3/2002	258.7	4/14/2003	Y	3/9/2003	
80	31.624		368		460	U	4/3/2002	258.7	5/18/2002	Y	3/9/2003	
81	31.643		485		850	U	4/8/2002	244.5	8/15/2002	Y	5/3/2003	8/15/2002
82	31.662		396		635	U	5/1/2001	271.5	6/30/2003	Y	6/1/2002	
83	31.683		409		627	U	4/11/2002	268.6	11/26/2003	Y	5/6/2003	
84	31.702		429		568	U	4/11/2002	270.6	4/11/2002	N	5/6/2003	
85	31.722		485		1079	F	5/2/2002	266.6	10/15/2002	Y	5/27/2003	
86	31.802		506		1210	M	5/2/2002	266.6	6/24/2002	Y	12/23/2003	

Appendix 3. River kilometer locations of tributaries and other landmarks on the Kootenai River, British Columbia, Idaho, and Montana.

River kilometer (rkm)	Landmark
77.2	West Arm of Kootenay Lake
121	Kootenay River delta at Kootenay Lake
133	fixed location radio receiver in Kootenay River (1998)
170	Idaho-British Columbia border (Porthill)
240.6	Deep Cr., ID
246	Bonners Ferry, ID
258.6	Moyie R., ID
264.8	Katka Cr., ID
266.9	Sand Cr., ID
268.5	Debt (John Crown) Cr., ID
270.6	Caboose Cr., ID
272.2	Curley Cr., ID
275.4	Boulder Cr., ID
275.7	Idaho-Montana border
279.2	Pine Cr., MT
285.5	Yaak R., MT
285.6	Star Cr., MT
291.4	Ruby Cr., MT
293.1	Brush Cr., MT
299.5	Callahan Cr., MT
300.3	Lake Cr., MT
301.2	O'Brien Cr., MT
308-310	Kootenai Falls, MT

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